# Reconfiguration of Webb-style Gliders for Routine Turbulence Measurements

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Award #: N00014-08-1-0422
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## LONG-TERM GOALS

The long-term goal of this program is to understand the physics of small-scale oceanic processes including internal waves, hydraulics, turbulence and microstructure that act to perturb and control the circulation in coastal oceans and, in doing so, affect the propagation of sound and light. Ongoing studies within the **Ocean Mixing Group** at OSU emphasize observations, interaction with turbulence modelers and an aggressive program of sensor / instrumentation development and integration. This includes extending measurements to new platforms such as gliders so that we can make continued measurements where ships cannot go (or when they cannot be there, such as during periods of extreme surface forcing).

## OBJECTIVES

Gliders offer a means of making two very valuable types of relatively autonomous measurements in the ocean. The first is the type of repeated routine observation that permits establishment of a climatology from which significant deviations can be identified and addressed. The second is the observation of extreme events (such as hurricanes) that cannot be made from ships. Over the past 20 years, we have established standards of ocean turbulence measurements and have extended our ship-based vertical and horizontal profiling packages to moored mixing measurements. It has been a natural evolution to use this expertise to integrate new sensors into gliders that will both begin to define climatologies of mixing in coastal waters and lead to turbulence measurements in events such as hurricanes for which we have limited or no observation.

In particular, the mechanical design of the Webb Research glider is robust and proven. The prospects for measuring turbulence and surface waves on these gliders have been recently tested by us by strapping a turbulence / motion-sensing package to both OSU and Rutgers gliders. Results have been sufficiently encouraging that we are now reconfiguring two existing gliders (one at Oregon State University, the other at Rutgers University) to achieve the following objectives from an integrated package:

- routine and continuous measurement of turbulence in the form of the temperature variance dissipation rate, $\chi$, the turbulence kinetic energy dissipation rate, $\varepsilon$, and the turbulence diffusion coefficients, $K_T$ and $K_\rho$;
- routine and continuous measurement of water-column velocity;

| **Report Documentation Page** | *Form Approved* *OMB No. 0704-0188* |
|---|---|



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **30 SEP 2008** | **Annual** | **00-00-2008 to 00-00-2008** |

| 4. TITLE AND SUBTITLE | |
|---|---|
| **Reconfiguration Of Webb-style Gliders For Routine Turbulence Measurements** | 5a. CONTRACT NUMBER |
| | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Oregon State University,College of Oceanic & Atmospheric Sciences,Corvallis,OR,97331-5503** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT

**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES

**code 1 only**

14. ABSTRACT

**The long-term goal of this program is to understand the physics of small-scale oceanic processes including internal waves, hydraulics, turbulence and microstructure that act to perturb and control the circulation in coastal oceans and, in doing so, affect the propagation of sound and light. Ongoing studies within the Ocean Mixing Group at OSU emphasize observations, interaction with turbulence modelers and an aggressive program of sensor / instrumentation development and integration. This includes extending measurements to new platforms such as gliders so that we can make continued measurements where ships cannot go (or when they cannot be there, such as during periods of extreme surface forcing).**

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **Same as Report (SAR)** | **4** | |

- routine measurement and transmission of significant wave height and direction when surfaced using a 6-axis accelerometer package;
- detection of nonlinear internal waves using the same motion package and transmission of wave properties.

## APPROACH

To date, we have added external turbulence pods to gliders. These pods include inertial motion (6 components of acceleration), fast thermistors, shear probes and gust probes (to measure three components of velocity with multiple pitot tubes). Analyses of the data obtained to date will be used to refine the components to be incorporated into a fully-integrated turbulence package.

## WORK COMPLETED

Tests were conducted in June 2008 over Stonewall Bank on Oregon's continental shelf (Figure 1). These were coordinated with Chameleon turbulence profiling. A glider launched with an external turbulence package and internal inertial motion package was launched by the Rutgers glider group off NJ in early September 2008 to encounter Tropical Storm Hanna, which it did. This glider will be recovered in early October.


***Figure 1 – Photograph of Webb glider with external turbulence pods (above nose at right) and turbulence profiler, Chameleon (left). A comparative experiment was conducted in June 2008 over Stonewall Bank on Oregon's continental shelf.***

## RESULTS

Glider sections of temperature and of Cox number derived from fast thermistor measurements on the OSU glider's external turbulence package are shown in Figures 2, 3. Arrows in Fig. 3 shows regions of near-surface wind mixing and near-bottom mixing over the bank, possibly due to accelerated, supercritical flows there (Moum & Nash, 2000; Nash & Moum, 2001).

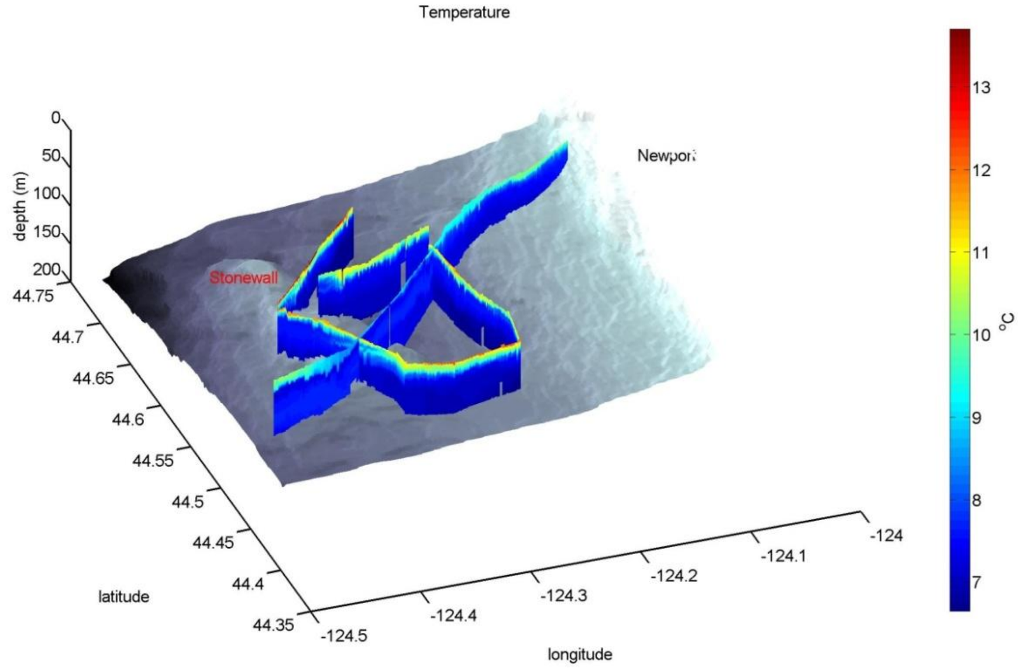


***Figure 2 – Glider sections of temperature over Stonewall Bank (June 2008).***

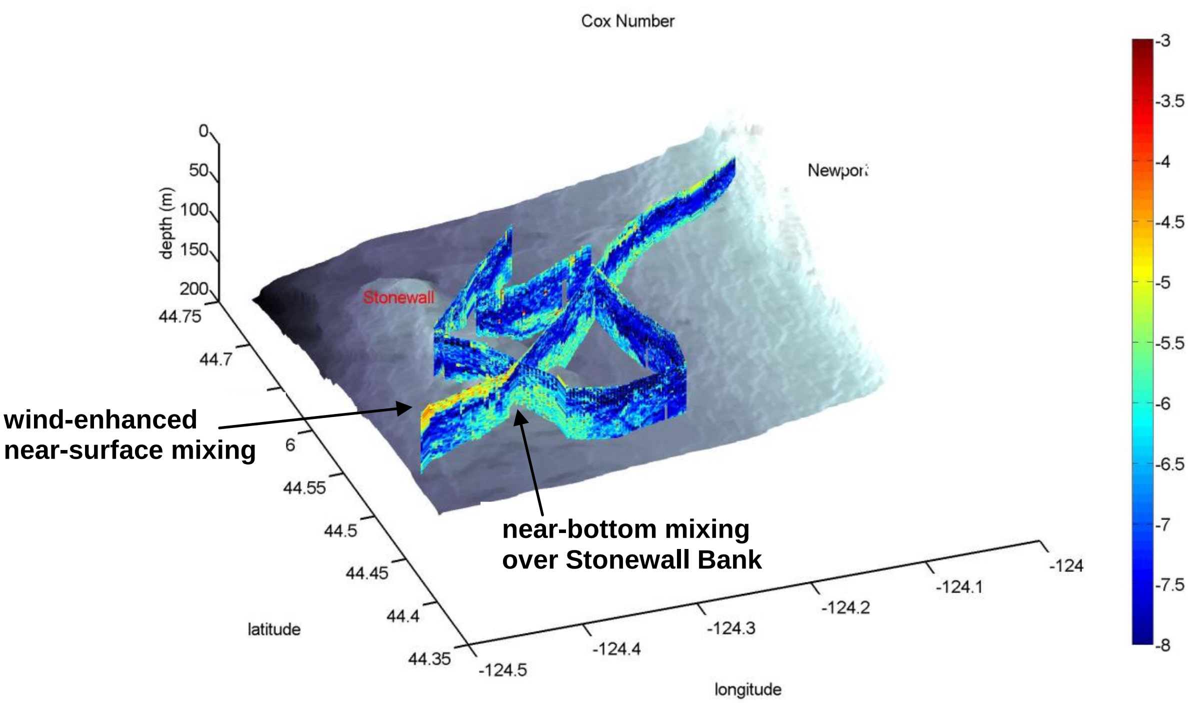


***Figure 3 — Glider sections of Cox number over Stonewall Bank (June 2008) show enhanced turbulence associated with flow over Stonewall Bank. Cox number is determined from the high wavenumber temperature gradient variance and related to the turbulence diffusivity via an advection-diffusion balance of the evolution equation for temperature variance.***

## REFERENCES

Moum, J.N and J.D. Nash, 2000: Topographically-induced drag and mixing at a small bank on the continental shelf. *J. Phys. Oceanogr.* , **30**, 2049-2054.

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